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(54) Plate heat exchanger and method for manufacturing a plate heat exchanger

(57) The invention relates to a plate heat exchanger, which comprises a plate pack formed by corrugated heat exchange plates with openings for the flow of a first and a second heat exchange medium. The outer shell of the plate heat exchanger (1) has been formed by arranging separate strips (9, 9') in the outer edge of the plate pack (2) so that the outer surfaces of the strips (9, 9') are substantially in the same plane with the outer edges of the heat exchange plates (6, 6'), and by welding the strips (9, 9') and the outer edges of the heat exchange plates (6, 6') to each other.

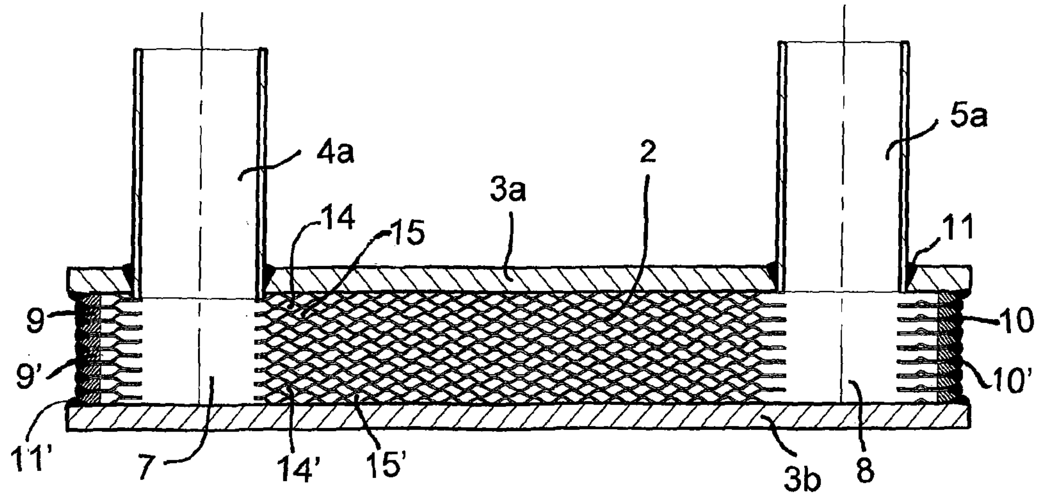

Fig. 2

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Description

Technical field of the invention

[0001] The invention relates to a plate heat exchanger and a method for manufacturing a plate heat exchanger according to the preambles of the independent claims presented below.

Background of the invention

[0002] In a typical prior art plate heat exchanger several rectangular heat exchange plates have been fastened on top of each other, the plates thus forming a plate pack. The plates of a plate heat exchanger are usually corrugated. The corrugation, i.e. the grooves and the ridges between them, aims to improve heat exchange properties and to cause a turbulent flow, which improves heat transfer coefficients. Typically, the plate pack is sealed with rubber sealing or the like, the sealings having been arranged in every plate space. Typically, the plate pack has been formed of heat exchange plates with openings, which openings form flow channels in the plate pack. The openings of the plate heat exchanger have been sealed in every other plate space, wherein the openings form flow channels for a first and a second heat exchange medium so that a flow of the first heat exchange medium passes through every second plate space of the plate pack and a flow of the second heat exchange medium passes through every second plate space. The plate pack has been supported between two rigid end plates and tensioned by clamp bolts.

[0003] A disadvantage in plate heat exchangers equipped with sealings has been their poor resistance especially to pressure, but also to temperature and corrosion.

[0004] Also known are heat exchangers, in which several heat exchange plates or plate pairs are brazed to each other at several places and thus fastened to each other to form a plate pack. In this way, pressure resistance of the rectangular plate heat exchangers has been improved. The brazed structure withstands pressure quite well, but by reason of properties of the filler metal the brazed structures do not withstand high temperatures. The welded structures have also been used in rectangular plate heat exchangers. For example, heat exchange plates with curved outer edges arranged one upon the other have been welded together for forming a plate pack, wherein a welded joint has been formed between each plate. However, this kind of welded plate pack structure has to close between the separate end plates, which have been firmly bonded together in order to achieve a pressure-proof structure.

[0005] A plate heat exchanger of the Plate & Shell type, which consists of a plate pack formed by circular heat exchange plates and a shell surrounding it, or a coil heat exchanger with a cylindrical outer shell are usually used at higher pressures. However, the heat exchange properties of the circular heat exchangers are not as good as the rectangular heat exchangers.

Summary of the Invention

[0006] It is an object of the present invention to reduce or even eliminate the above-mentioned disadvantages appearing in prior art.

[0007] It is particularly an object of the present invention to provide a plate heat exchanger that resists pressure, high temperatures and rapid changes in the temperatures well.

[0008] An object of the present invention is particularly to provide a plate heat exchanger with good heat exchange properties.

[0009] It is particularly an object of the present invention to provide a plate heat exchanger that has a simple pressure-proof structure without a separate shell around the plate pack. So, it is especially an object of the present invention to provide a plate heat exchanger, the manufacturing of which is inexpensive and easy.

[0010] In order to achieve among others the objects mentioned above, the method for manufacturing a plate heat exchanger and the plate heat exchanger of the invention are characterized by what is presented in the characterizing parts of the enclosed independent claims.

[0011] The embodiments and advantages mentioned in this text relate, where applicable, both to the plate heat exchanger and the method for manufacturing a plate heat exchanger according to the invention, even though it is not always specifically mentioned.

[0012] A typical plate heat exchanger according to the invention comprises

- a plate pack formed by arranging corrugated heat exchange plates one upon the other, where each heat exchange plate has openings,
- flow channels inside the plate pack for at least a first and a second heat exchange medium formed by means of the openings of the heat exchange plates and which openings have been attached to each other at their outer perimeters so that through every second plate space of the plate pack is passed a flow of the first heat exchange medium and through every second plate space is passed a flow of the second heat exchange medium,
- inlet and outlet connections for the first and second heat exchange medium, which have been arranged in connection with the flow channels,

  and in which heat exchanger the outer shell of the plate heat exchanger has been formed by arranging separate strips in the outer edge of the plate pack so that the outer surfaces of the strips are substantially in the same plane with the outer edges of the heat exchange plates, and by welding the strips and the outer edges of the heat exchange plates to each other.

[0013] A typical method according to the invention for manufacturing a plate heat exchanger has at least the following steps:

- arranging corrugated heat exchange plates one upon the other as a plate pack, where each heat exchange plate has openings and which openings form flow channels inside the plate pack for at least a first and a second heat exchange medium,
- attaching the heat exchange plates in connection to each other at the outer perimeters of the openings so that through every second plate space of the plate pack is passed a flow of the first heat exchange medium and through every second plate space is passed a flow of the second heat exchange medium,
- arranging inlet and outlet connections for the first and the second heat exchange medium in connection with the flow channels,
- arranging separate strips in the outer edge of the plate pack so that the outer surfaces of the strips and the outer edges of the heat exchange plates are substantially in a same plane, and
- welding the strips and the outer edges of the heat exchange plates to each other.

[0014] Some preferred embodiments of the invention will be described in the other claims.

[0015] The structure of the plate heat exchanger according to the invention is based on the fact that the heat exchanger does not comprise a separate shell around a plate pack as a pressure vessel or as a supporting structure, but the outer edge of the plate pack of the heat exchanger according to the invention has been constructed so that it forms the pressure-proof outer shell of the heat exchanger. In other words, the heat exchanger according to the invention is not arranged inside a pressure-proof housing, but the structure of the plate pack is pressure-proof itself.

[0016] One advantage of the invention compared to the brazed heat exchanger constructions is that the heat exchange plates of the heat exchanger according to the invention are clear from filler or brazing materials and so the plates do not comprise any additional materials or barrier layers which weaken heat exchange properties. So, the manufacturing method of a heat exchanger according to the invention improves heat exchange properties. The completely welded structure of the invention also withstands high temperatures and rapid changes of temperatures better than the brazed heat exchangers known in the prior art.

[0017] The structure of the plate heat exchanger of the invention is completely welded, i.e. all elements of the heat exchanger are welded tightly to each other. Thus, one advantage of the invention is that the structure of the plate heat exchanger of the invention is simple, since it does not comprise any fastenings, sealings or gaskets between the elements, but they are replaced by the welded structures. The welded joints seam the strips arranged in the outer edge of the plate pack and the heat exchange plates together so that no separate fastenings or gaskets are needed, i.e. the structure of the heat exchanger of the invention is a non-gasket structure. The completely welded structure of the heat exchanger forms a compact pressure-proof element.

[0018] The pressure-proof outer surface of the heat exchanger of the invention is formed by arranging separate strips in the outer edge of the plate pack so that the outer surfaces of the strips and the outer edges of the heat exchange plates are substantially in the same plane, and by welding the strips and the outer edges of the heat exchange plates to each other. In an embodiment of the invention, the separate strips are arranged in the plate spaces of the plate pack. In a preferred embodiment of the invention, the strips are arranged between the pairs of heat exchange plates, in which pairs the outer edges of adjacent heat exchange plates are arranged against each other. In other words, in the preferred embodiment of the invention the outer surface of the plate pack comprises alternately strip and outer edges of two adjacent heat exchange plates in vertical direction of the plate pack. The strips circulate the whole outer edge of the plate pack for forming a uniform outer surface of the plate pack.

[0019] In a preferred embodiment of the invention, the outer edges of two adjacent heat exchange plates and two strips arranged in the outer edge of the plate pack are welded together by one welded seam. Preferably, the outer edges of the superposed heat exchange plates (i.e. a pair of the heat exchange plates) and strips arranged on both sides of the plate pair are welded to each other by one welded seam. Thus, the amount of the welded joints can be significantly reduced in the plate pack structure compared to the structures wherein all plates have been welded to each other. Thus, the structure of the heat exchanger of the invention will also accelerate the manufacturing of the heat exchanger.

[0020] The separate strips which have been arranged to circulate around the whole plate pack in the spaces of the plate pairs form a uniform outer shell of the heat exchanger of the invention, after the strips are welded together with the outer edges of the heat exchange plates. The strips also support the structure of the heat exchanger of the invention, and so no separate supporting structure around the plate pack is needed.

[0021] The thickness of the strips is equal to the gap between two adjacent heat exchange plates, in which gap the strip is arranged. Typically, the thickness of the strip is 1 to 10 mm, or 1 to 5 mm, in a vertical direction of the plate pack.

[0022] Typically, the width of the strip in the direction of the heat exchange plates is 3 to 20 mm. The width of the strips is dependent on the required pressure resistance of the heat exchanger.

[0023] In an embodiment of the invention, the strip comprises at least one chamfered edge. Typically, both edges of the strip are chamfered symmetrically. The chamfered edges ensure a good penetration of the welded joint into the structure, and so the strength of the structure of the heat exchanger will improve. Especially, the chamfered edges of the strips make possible the increasing of the penetration without increasing the welding power.

[0024] According to an embodiment of the invention, the two or more uppermost and lowest heat exchange plates of the plate pack are welded to each other so that at least part of the contact surfaces of the plates are welded to each other for forming an end plate of the heat exchanger. Typically, 2 to 10 adjacent heat exchange plates are welded to each other in both ends of the plate pack. At the contact surfaces of the plates, ridges and grooves of the adjacent corrugated plates have been arranged in contact with each other. In the method according to the invention, a keyhole laser beam welding technique is preferably used. The keyhole laser welding makes possible that the welded joints are only formed at the points, where the superposed heat exchanger plates are in connection with each other. These heat exchange plates welded to each other form rigid end plates of the heat exchanger, and so separate end plates are not needed, i.e. the end plates which traditionally bind the stack of plates can be left out. The structure of the heat exchanger according to this embodiment of the invention is a so-called a self-supportive structure. This is the fact especially if the heat exchange medium flowing between plate spaces is not under high pressure.

[0025] According to another embodiment of the invention, the separate end plates are arranged under and over the plate pack in connection with the uppermost and the lowest heat exchange plate, i.e. an end plate is arranged in both ends of the plate pack. Preferably, the straight end plates are welded to uppermost and the lowest heat exchange plate so that at least part of the contact surfaces of the plate and the end plate is welded to each other. For example, the ridges of corrugated heat exchange plate, or at least part of them, which are arranged against the end plate, are welded tightly to the end plate. By means of the strips arranged in the structure of the plate pack, the separate end plates have also been fastened to the structure of the plate pack. Typically, the thickness of the end plates is 20 to 100 mm. This structure can be used under high pressure, for example about 100 bar.

[0026] The pressure resistances of heat exchangers can of course be adjusted to be suitable for each case, for example, by varying the thickness of the end plates or by increasing the number of the welding points in which points the heat exchange plates are welded to the end plates or by increasing the number of the plates which are welded to each other by at least part of the contact surfaces of the plates.

[0027] The inlet and outlet connections for a first and a second heat exchange medium have been arranged through the end plate of the heat exchanger in connection with the flow channels, or the inlet and outlet connections are directly attached to the uppermost heat exchange plate when the separate end plates are not arranged in the structure. In an embodiment of the invention, the inlet and outlet connections are arranged close to ends of the heat exchanger in the longitudinal direction of the heat exchanger so that the inlet and outlet connections are arranged in the opposed ends. The inlet and outlet connections can be arranged in the same or different end plates of the heat exchanger, i.e. depending on the application the position of the connections can vary.

[0028] According to an embodiment of the invention, the inlet and outlet connections of one heat exchange medium are arranged at the same edge of the heat exchanger in the longitudinal direction of the heat exchanger. Preferably, the inlet and outlet connections of one heat exchange medium are arranged at the diagonal edges of the heat exchanger in the longitudinal direction of the heat exchanger.

[0029] In the method according to the invention, the flow channels of the first and the second heat exchange medium are formed inside the plate pack by arranging the openings of adjacent heat exchanger plates to face each other, i.e. both the flow of the first heat exchange medium and the flow of the second heat exchange medium have been arranged in connection to inner parts of the plate pack. The outer perimeters of the openings of the heat exchange plates are welded to each other without any filler material so that a flow of the first heat exchange medium passes through every second plate space and a flow of the second heat exchange medium passes through every second plate space. In other words, there are always different heat transfer media on the opposite sides of one heat exchange plate. Each heat exchange plate has at least two openings for the flow of the first heat exchange medium and two openings for the flow of the second heat exchange medium. The welded joint between two heat exchange plates placed upon each other is formed alternately in the flow channels of the first heat exchange medium and the flow channels of the second heat exchange medium, the outer perimeters of the openings of the adjacent plates are welded in pairs. Thus the heat exchange medium can flow from a flow channel connected to the inlet connection to another flow channel connected to the outlet connection via the plate spaces. The primary circuit of the plate heat exchanger is thus formed between the inlet and outlet connection of the first heat exchange medium. Respectively, the secondary circuit of the plate heat exchanger is formed between the inlet and outlet connection of the second heat exchange medium. The primary and secondary circuits are separate from each other.

[0030] Typically, the heat exchange plates of the invention have four openings, when it is used for the application with the first and the second heat exchange medium. The heat exchanger of the invention can also be applied to more than two heat exchange mediums. However, applications obtainable by a different number of openings are not a specific aim of this invention and are thus not explained more broadly.

[0031] The heat exchange plates according to the invention can be made of steel or another suitable material for example by cold working. The cold working reinforces the heat exchange plates. Typically, the thickness of a heat exchange plate is 0.5 to 1.5 mm. The thickness is dependent on the operating pressure of the heat exchanger.

[0032] Typically, the heat exchange plates are corrugated. The corrugation, i.e. the grooves and the ridges between them, aims to improve heat exchange properties and produces e.g. a diamond shape to the plate spaces which improves heat transfer coefficients. In an embodiment of the invention, the heat exchange plates comprise corrugations which form a fish bone structure in the plate. This kind of corrugations make possible the use of only one kind of corrugated heat exchange plates in the structure of the heat exchanger.

[0033] The heat transfer properties of a heat exchanger can be controlled with the corrugation of heat exchange plates. The heat exchanger and its parts are often designed for a specific use situation. The flow rate and properties, such as temperature, density and pressure, of heat exchange mediums have a substantial influence on the dimensioning of a plate heat exchanger and on the choice of an optimal plate profile. Different corrugations of plates and angles between the corrugations of adjacent plates need to be designed for different use conditions. In other words, different types of heat exchange plates are needed for different applications.

[0034] The external form of the heat exchanger of the invention is dependent on the shape of the heat exchange plates, which form the plate pack. The pressure-proof outer surface of the plate pack according to the invention can be formed in all shapes of the plate pack. Preferably, the plate pack is constructed of rectangular heat exchange plates, since the rectangle shape ensures better heat exchange properties. The width and the length of the rectangular heat exchange plate can vary depending on desired heat exchange properties. Typically, the width of the heat exchanger is 0.2 to 1.5 m, and the length is 0.2 to 6 m.

[0035] In an embodiment of the invention, the plate pack is constructed of circular heat exchange plates. The diameter of them is for example 0.2 to 1.5 meters.

[0036] One advantage of the invention is that the heat exchanger of the invention is easily mounted into machine units and corresponding constructions.

<u>Description of the drawings</u>

[0037] The invention is described in more detail below with reference to the enclosed schematic drawing, in which

Figure 1 shows a heat exchanger according to an embodiment of the invention,

Figure 2 shows a cross-section of the heat exchanger according to an embodiment of the invention,

Figure 3 shows one end of a heat exchange plate according to an embodiment of the invention, and

Figure 4 shows a cross-section of one flow channel of the heat exchanger according to an embodiment of the invention.

<u>Detailed description of the invention</u>

[0038] For the sake of clarity, the same reference numbers are used for corresponding parts in different embodiments.

[0039] Figure 1 shows a plate heat exchanger 1 according to an embodiment of the invention from outside. The plate heat exchanger 1 comprises a plate pack 2 formed by heat exchange plates and end plates 3a, 3b arranged under and over the plate pack 2 in connection with the uppermost and the lowest heat exchange plates. The inlet connection 4a and outlet connection 4b for the first heat exchange medium lead through the end plate 3a to the inside of the plate pack 2. The inlet connection 5a and outlet connection 5b of the second heat exchange medium also lead through the end plate 3a to the inside of the plate pack 2. The inlet and outlet connections 4a, 4b, 5a, 5b are arranged in connection with the flow channels of the plate pack 2. The flows of the first and the second heat exchange medium are shown with arrows in Figure 1. A pressure-proof outer shell of the heat exchanger has been formed by welding the outer perimeters of the heat exchange plates of the plate pack 2.

[0040] Figure 2 shows a cross-section of the heat exchanger according to an embodiment of the invention. Figure 4 shows an enlargement of a part of a cross-section of the heat exchanger. The structure showed in Figure 4 is equal with the structure of the heat exchanger showed in Figure 2.

[0041] A plate pack 2 formed by heat exchange plates 6, 6' is arranged between the end plates 3a, 3b. Inlet connections 4a, 5a have been welded tightly to the end plate 3a of the heat exchanger. Inlet connections 4a, 5a are in connection with the flow channels 7, 8 inside the plate pack. The openings of the heat exchange plates have been arranged to face each other in adjacent plates so that they form the inlet and outlet channels 7, 8 inside the plate pack for the first and the second heat exchange medium, flow channels 7 and 8 penetrating the entire plate pack 2. Figure 3 shows the detailed structure of the heat exchange plate.

[0042] A first heat exchange medium passes via inlet connection 4a to the flow channel 7 of the plate pack, from there further inside the plate spaces 14, 14' and to the other flow channel of the plate pack for the first medium (not shown in the Figure) and out of the flow channel via the outlet connection. Respectively, the second heat exchange medium passes via inlet connection 5a to the flow channel 8 of the plate pack, and from there inside the plate spaces 15, 15', which are arranged alternately with the plate space 14, 14' of the first heat exchange medium, and further to the other flow channel of the plate pack (not shown in the Figure) for the second heat exchange medium and out of the flow channel via outlet connection. The heat exchange plates 6, 6' are welded to each other at the outer perimeters of the openings of the plates so that through every second plate space is passed a flow of the first heat exchange medium and through every second plate space is passed a flow of the second heat exchange medium, reference numbers 12, 12' refers to these welded joints.

[0043] Separate strips 9, 9' have been arranged in the outer edge of the plate pack 2 so that the outer surfaces of the strips 9, 9' and outer edges of the heat exchange plates 6, 6' are substantially in the same plane and a uniform outer surface has been formed. Preferably, the separate strips 9, 9' are arranged between plate pairs, i.e. to a space between plate pairs, in which pair the outer edges of two heat exchange plates 6, 6' are arranged against each other as shown in Figures 2 and 4. The pair of heat exchange plates and the two strips 9, 9' arranged on both sides of the plate pair are welded together by a welded joint 10. The welded joints 10, 10' circulate the plate pack 2 and the welded structure attaching separate strips and the outer edges of the heat exchange plates forms the pressure-proof outer surface of the plate pack.

[0044] As shown in Figure 2 and 4, all elements of the heat exchanger of the invention are welded together. Reference numbers 11, 11' refer to welded joints between the inlet and outlet connections and the end plate, and between the plate pack and the end plates.

[0045] Figure 3 shows one end of a heat exchange plate 6 according to an embodiment of the invention. The corrugated surface of the heat exchange plate 6 comprises a fish bone structure as illustrated in Figure 3. The fish bone structure means that the grooves and ridges in the plate are approximately at a 45 degrees angle with respect to the median line of the heat exchange plate, in a different direction on different side of the median line. Preferably, the openings 13, 13' for heat exchange medium are arranged close to the corners of the heat exchange plate. Each heat exchange plate has at least two openings for the flow of the first heat exchange medium and at least two openings for the flow of the second heat exchange medium.

[0046] The figures show only a few preferred embodiments according to the invention. It is obvious to someone skilled in the art that the invention is not limited merely to the above-described examples, but the invention may vary within the scope of the claims presented below.

Claims

1. A plate heat exchanger (1), which comprises

   - a plate pack (2) formed by arranging corrugated heat exchange plates (6, 6') one upon the other, where each heat exchange plate (6, 6') has openings (13, 13'),
   - flow channels (7, 8) inside the plate pack (2) for at least a first and a second heat exchange medium formed by means of the openings (13, 13') of the heat exchange plates (6, 6') and which openings (13, 13') have been attached to each other at their outer perimeters so that through every second plate space (14, 14') of the plate pack is passed a flow of the first heat exchange medium and through every second plate space (15, 15') is passed a flow of the second heat exchange medium,
   - inlet and outlet connections (4a, 4b, 5a, 5b) for the first and second heat exchange medium, which have been arranged in connection with the flow channels (7, 8),

   characterized in that an outer shell of the plate heat exchanger (1) has been formed by arranging separate strips (9, 9') in the outer edge of the plate pack (2) so that the outer surfaces of the strips (9, 9') are substantially in the same plane with the outer edges of the heat exchange plates (6, 6'), and by welding the strips (9, 9') and the outer edges of the heat exchange plates (6, 6') to each other.

2. The plate heat exchanger according to claim 1, **characterized in that** the outer shell comprises the strips (9, 9') between the pairs of heat exchange plates (6, 6'), in which pairs the outer edges of adjacent heat exchange plates (6, 6') are arranged against each other.

3. The plate heat exchanger according to claim 2, **characterized in that** the outer edge of the plate pair and two strips (9, 9') arranged on both sides of the plate pair have been welded by one welded seam (10).

4. The plate heat exchanger according to any of the preceding claims, **characterized in that** at least part of the contact surfaces of two or more uppermost and lowest heat exchange plates of the plate pack (2) have been welded to each other.

5. The plate heat exchanger according to any of the preceding claims 1 to 3, **characterized in that** the heat exchanger (1) comprises end plates (3a, 3b), which have been arranged under and over the plate pack (2) in connection with the uppermost and the lowest heat exchange plate.

6. The plate heat exchanger according to any of the preceding claims, **characterized in that** the strip (9, 9') comprises at least one chamfered edge.

7. The plate heat exchanger according to any of the preceding claims, **characterized in that** the width of the strip (9, 9') in the direction of the heat exchange plate is 3 to 20 mm.

8. The plate heat exchanger according to any of the preceding claims, **characterized in that** the thickness of the heat exchange plate (6, 6') is 0.5 to 1.5 mm.

9. The plate heat exchanger according to any of the preceding claims, **characterized in that** the heat exchange plates comprise corrugations which form a fish bone structure in the plate.

10. The plate heat exchanger according to any of the preceding claims, **characterized in that** the structure of the heat exchanger (1) is completely welded to form a compact element.

11. The plate heat exchanger according to any of the preceding claims, **characterized in that** the plate pack (2) has been constructed of rectangular heat exchange plates (6, 6').

12. Method for manufacturing a plate heat exchanger (1), the method comprising at least the following steps:

- arranging corrugated heat exchange plates (6, 6') one upon the other as a plate pack (2), where each heat exchange plate (6, 6') has openings (13, 13') and which openings form flow channels 7, 8) inside the plate pack for at least a first and a second heat exchange medium,
- attaching the heat exchange plates (6, 6') in connection to each other at the outer perimeters of the openings (13, 13') so that through every second plate space (14, 14') of the plate pack is passed a flow of the first heat exchange medium and through every second plate space (15, 15') is passed a flow of the second heat exchange medium,
- arranging inlet and outlet connections (4a, 4b, 5a, 5b) for the first and the second heat exchange medium in connection with the flow channels (7, 8),

characterized in

- arranging separate strips (9, 9') in the outer edge of the plate pack (2) so that the outer surfaces of the strips (9, 9') are substantially in a same plane with the outer edges of the heat exchange plates (6, 6'), and
- welding the strips (9, 9') and the outer edges of the heat exchange plates (6, 6') to each other.

13. The method according to claim 12, **characterized in that** the strips (9, 9') are arranged between the pairs of heat exchange plates (6, 6'), in which pairs the outer edges of adjacent heat exchange plates (6, 6') are arranged against each other, and the outer edge of the plate pair and the two strips arranged on both sides of the plate pair are welded by one welded seam (10).

14. The method according to claims 12 or 13, **characterized in that** at least part of the contact surfaces of two or more uppermost and lowest heat exchange plates of the plate pack (2) are welded to each other.

15. The method according to claims 12 or 13, **characterized in that** the end plates (3a, 3b) are arranged under and over the plate pack (2) in connection with the uppermost and the lowest heat exchange plate.

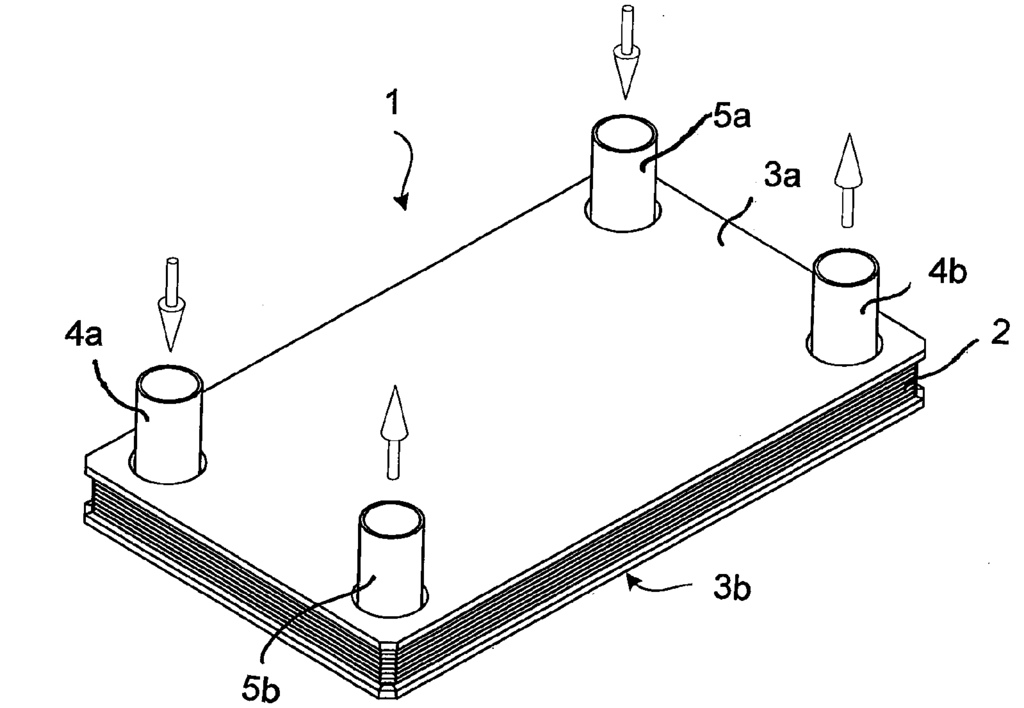

Fig. 1

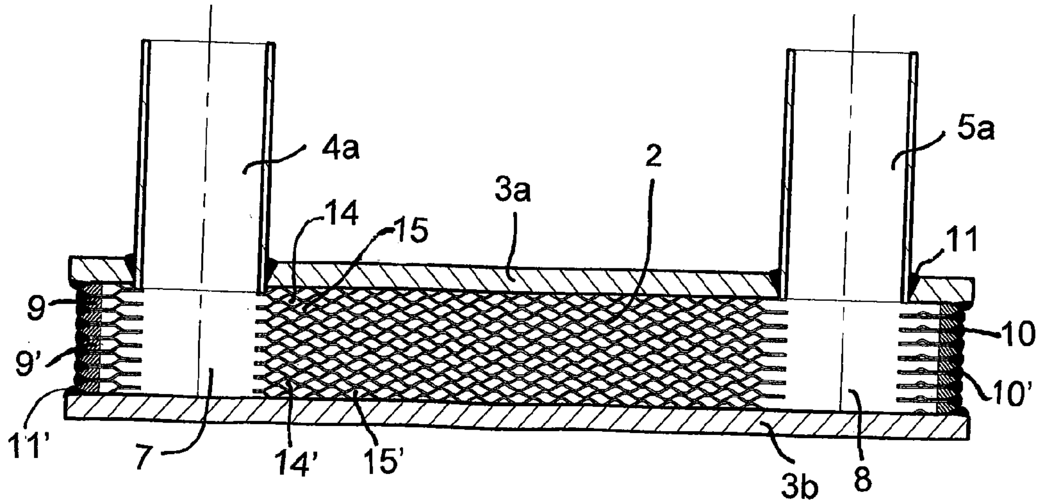

Fig. 2

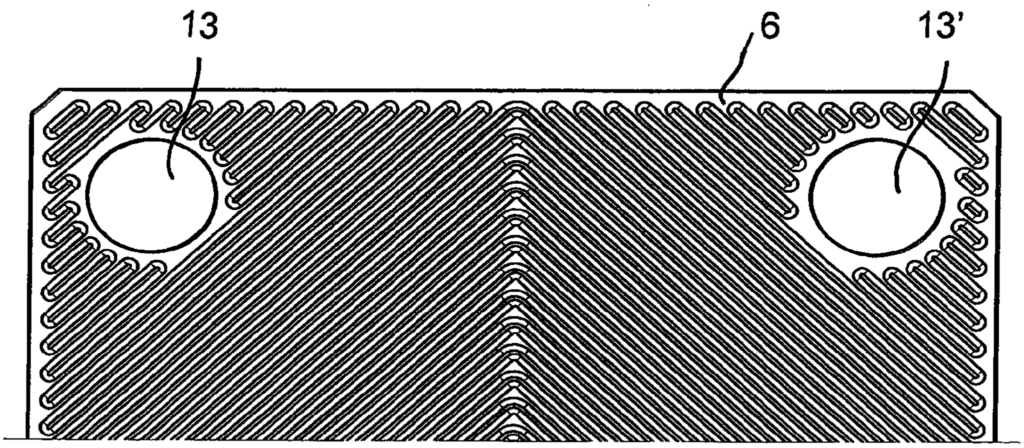

Fig. 3

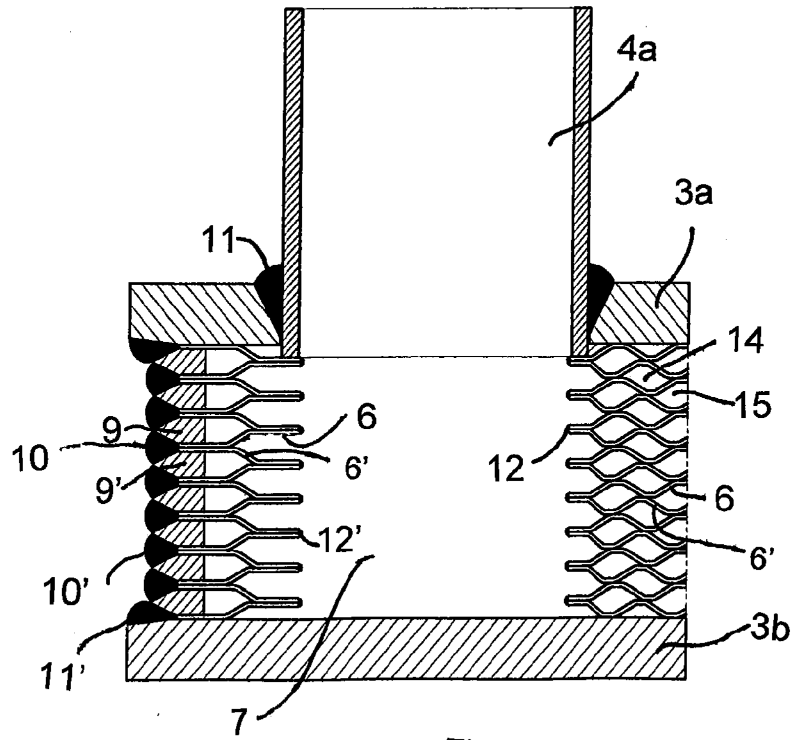

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 11 19 3185

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	WO 93/06426 A1 (APV CORP LTD [GB]) 1 April 1993 (1993-04-01) * figure 3 * -----	1,2,7-12	INV. F28D9/00 F28F3/10 B21D53/04
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Y	WO 2007/036963 A1 (CANDIO GIANNI [IT]; TAVECCHIO GILDO [IT]) 5 April 2007 (2007-04-05) * figure 2 * -----	1,2,7-12	
			TECHNICAL FIELDS SEARCHED (IPC)
			F28D F28F B21D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 April 2012	Mellado Ramirez, J

1

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 19 3185

17-04-2012

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